THE

ONTARIO WATER RESOURCES

COMMISSION

PRELIMINARY REPORT

on the

INFLUENCE OF INDUSTRIAL ACTIVITY

on the

LAKES IN THE SUDBURY AREA

1969 - 1970

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THE LAKES IN THE SUDBURY AREA

Sudbury

1969 - 1970

prepared by

Ontario Water Resources Commission

in co-operation with

The Department of Lands & Forests

and

The Air Management Branch

Department of Energy & Resources Management

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INTRODUCTION

During the fall of 1969, staff of the Commission organized an interdepartmental group to study the problem of low pH and declining fish populations in the lakes of the Sudbury area. The group represented the Air Management Branch of the Department of Energy and Resources Management, the Department of Lands and Forests and the Ontario Water Resources Commission.

The aims were to determine the existence, extent and nature of the problem, the mechanism by which aquatic life was affected, and means of rehabilitating affected lakes. The initial step was to collect all available water chemistry data for the area, and realizing that limited data were available, a monitoring program was initiated, including lake, snow and rainfall samples, to complement the data. Because a new 1250 foot stack was being constructed by INCO at Copper Cliff, the monitoring program was extended to provide background data for lakes a considerable distance from Sudbury.

This interim report is a compilation of the data collected to date. An attempt is made to correlate this information with data collected by Mr. B. Dreisinger, M.F. Sulphur Fumes Arbitrator, and data presented by Mr. D. Hughson, Department of Lands and Forests, on declining fish populations in the Sudbury area.

SUMMARY

1) Data collected to date indicate that a serious and widespread problem exists. The extent is illustrated by the existence of lakes located in remote areas more than 40 air miles from Sudbury, having pH levels of less than 5.0 units, and the seriousness by the extent of the loss of Lake Trout and Pickerel fisheries.

2) Insufficient data are available to determine whether a significant change in water chemistry has been occurring in the lakes during the past two decades. Data collected as a result of the recently implemented monitoring program displays various unexplained anomalies. One of the most important anomalies may be the significant metal concentrations in lakes in the Temagami area.

3) Documented evidence is available to show that many fisheries have either deteriorated or been completely lost over the past two decades. It is conservatively estimated that a total of 25,000 acres of Pickerel water and 17,000 acres of Lake Trout water have been completely lost.

4) Data are presented which indicate that emissions to the atmosphere from the Sudbury industrial complex may be making a significant contribution to the impairment of surface waters in the Sudbury area. However, a direct correlation between atmospheric fallout and low pH and heavy metal concentration in lakes in the Sudbury area has not been established.

5) The data available is too limited to determine a relationship between declining fisheries and low pH and high metal concentration in lakes in the Sudbury area. The co-existence,in a substantial number of lakes, of these conditions may be significant in view of the evidence in the literature attesting to the adverse effects of reduce pH and heavy metal concentrations in fish and other aquatic organisms.

CONTINUING PROGRAM

In view of the data collected, it is the committee's opinion, that the following must be considered if the initial objectives of the committee are to be realized.

1) Lake, snow and rainfall sampling programs be continued and be extended as required, to determine the extent and magnitude of atmospheric fallout in the Sudbury and surrounding areas.

2) Stack emission monitoring for the industrial complex in Sudbury be continued for both particulate and gaseous components, and this data correlated with atmospheric fallout data.

3) Anomalies existing in the data collected to date be investigated, especially the unexpected metal concentrations in lakes in the Temagami area. This should entail an investigation of bedrock geology, soil conditions, flushing rates and any other parameter which could be an important factor in determining the water chemistry in each individual lake basin.

4) Biological studies be conducted to determine the interrelation between declining fisheries, aquatic communities and water chemistry in the lakes. This will provide the groundwork for a study on lake rehabilitation.

DESCRIPTION OF THE SUDBURY AREA

In 1968, about 52% of the free world's nickel supply worth almost $400 Million was extracted from mines in the Sudbury basin. Most of the copper produced in Ontario also comes from the Sudbury mines as well as virtually all of the platinum metals produced in Canada. Altogether, there are 15 separate mineral products and by-products extracted from the Sudbury ores, including gold, silver, cobalt, selenium, tellurium and osmium.

Two main companies operate in the area - The International Nickel Company of Canada Limited and Falconbridge Nickel Mines Limited. The former company operates two smelters in the area, the largest at Copper Cliff, five miles west of Sudbury and a second at Coniston, nine miles east of Sudbury. The smelter for the Falconbridge operation is located in the town of Falconbridge, ten miles northeast of Sudbury. In addition to the smelters, each of the companies operates an iron-ore recovery plant. Sulphur dioxide gas and particulate material are discharged from these operations into the atmosphere around Sudbury.

In the Sudbury area, the prevailing wind is from the southwest during the summer and generally from the north during the winter (see tables No. I&II), resulting in the major stack fallout zones being in a northeast and southwest direction from Sudbury. For ease of data presentation in this report, the Sudbury basin has been divided into four quadrants located northeast, northwest, southeast and soutwest from Sudbury (see figure I).

Most of the lakes included in the monitoring scheme are lakes which have no known industrial waste input. Exceptions are Agnew Lake, Kelly Lake, Clarabelle Lake, Lady McDonald Lake, Vermillion Lake and Meatbird Lake. The data presented in this report are representative therefore, of lakes with no industrial input and the conclusions drawn are likewise based on lakes with no industrial waste input.

TABLE NO. 1

Mean percentage frequencies of wind directions recorded at Sudbury during the period of 1947 through 1954

% Frequency

Wind	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
N	11	11	12	9	11	8	7	10	7	10	11	11
NE	16	15	15	16	16	10	9	13	8	11	12	12
E	20	16	15	15	11	10	5	8	9	10	11	14
SE	7	6	6	3	7	6	4	5	8	8	11	8
S	6	9	10	13	11	16	12	9	12	12	11	8
SW	17	18	17	19	19	28	35	26	25	22	20	18
W	4	6	7	7	9	7	11	9	12	10	7	9
NW	15	15	15	15	14	14	16	18	17	15	16	18
Calm	4	4	3	3	2	1	1	2	2	2	1	2
Prevailing Wind	E	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW & NW

TABLE NO. II

Mean percentage frequencies of wind directions recorded at Sudbury

during the period 1955 through 1965

% Frequency

Wind	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
N	17	18	20	16	14	12	11	11	9	11	9	12
NE	12	12	20	17	12	13	9	11	10	10	9	12
E	7	6	7	8	5	5	5	5	5	6	8	7
SE	10	9	6	9	7	4	5	7	8	11	13	9
S	10	11	11	11	15	14	11	13	18	18	15	13
SW	14	14	11	12	19	21	22	19	20	16	14	13
W	11	11	9	11	12	16	19	16	16	13	14	12
NW	15	14	11	13	12	12	15	14	12	14	15	16
Calm	6	6	7	5	5	5	5	6	4	4	5	8
Prevailing Wind	N	N	N & NE	NE	SW	SW	SW	SW	SW	S	S & NW	NW

DETAILS OF INVESTIGATION

Fish popultions have been declining in the Sudbury district, and it was assumed that this phenomenon could be related to changes in the water chemistry of the lakes. In order to verify this assumption,it was necessary to establish the extent of the change in water chemistry by comparing background data with present conditions. To achieve this end, a monitoring program was instituted to define present conditions and to establish seasonal trends. This included the collection of lake water samples, snow samples, and rainfall samples.

Lake Water Samples

Except for the lakes close to Sudbury, all lakes were sampled with the use of aircraft. For this reason, only lakes large enough to facilitate landings were sampled. All samples were collected in glass bottles within two feet of the lake surface and although no attempt was made to preserve the samples, a pH analysis was completed within eight hours of sample collection.

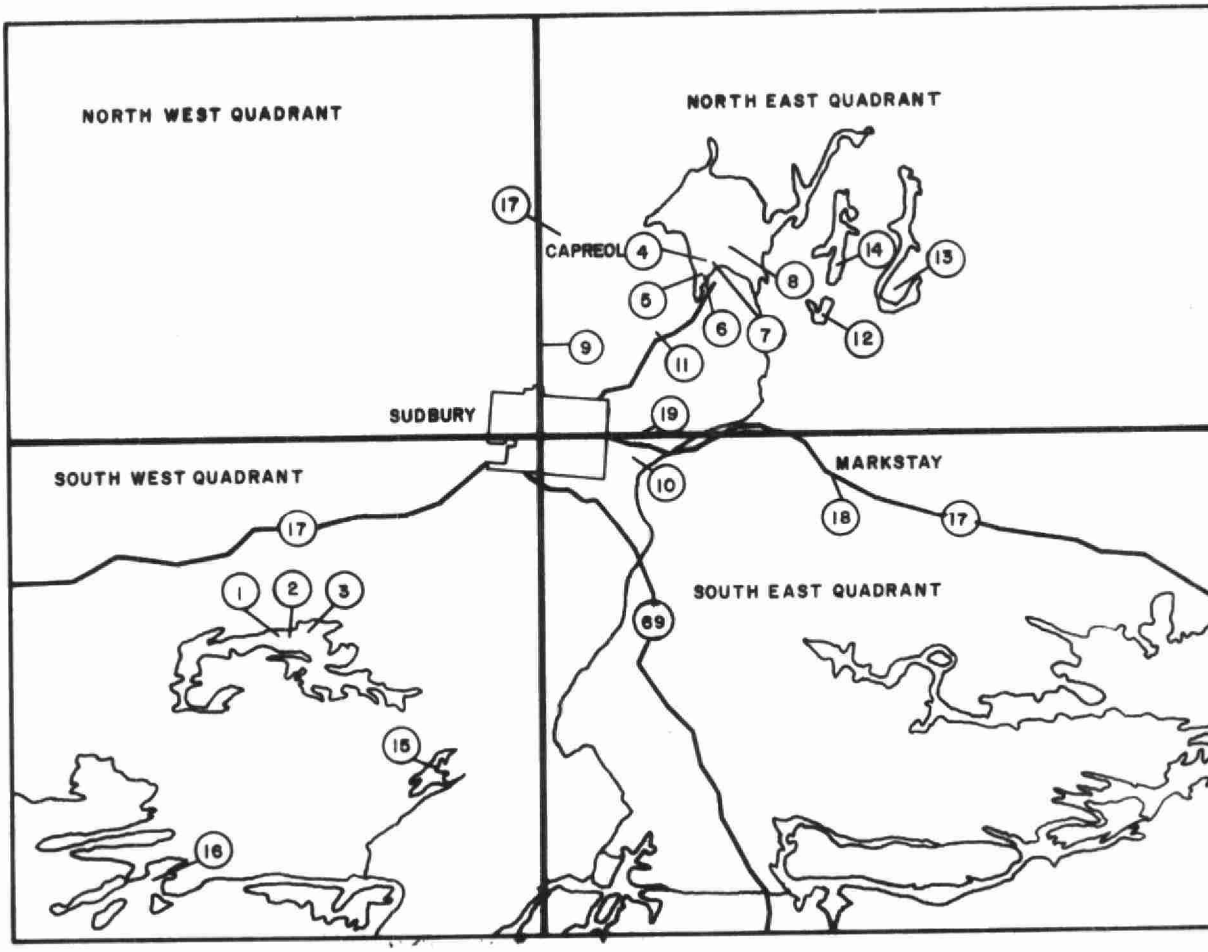
A summation of all the data collected is presented in Appendix A.

Snow Samples

Snow sample collection points were scattered throughout the area as designated on Figure 1. All sampling points except 9,10,11 and 18 were located a minimum of 100 feet from a highway and 1000 feet from a railway. The method of obtaining snow samples was to collect a rectangular block of snow about 2-4 inches deep and of sufficient surface area to provide a ten pound sample.

FIGURE I

Snowfall Sampling Locations



Details

No.	Location
1	Lake Penage
2	Lake Penage
3	Lake Penage
4	Lake Wanapitei
5	Lake Wanapitei
6	Lake Wanapitei surface
7	Accum
8	Lake Wanapitei
9	Lot 2, Con. 6, Blezard Twp.
10	Opposite 83 Caruso St., Coniston
11	Hwy. 541, 1 mile from Bailey corner
12	Ashigami Lake
13	Chiciguchi Lake
14	Kugagami Lake
15	Tyson Lake
16	Killarney Lake
17	Frenchman Lake
18	Hwy. 17 - Markstay
19	Hwy. 17 - Coniston
20	La Motte Lake
21	Mesokenda Lake

These samples were transported to and stored in the office in plastic bags. When the sample was partially melted, the liquid portion was used to fill sample bottles for analysis. Concentrations are listed in Appendix B for these melted snow samples.

Rainfall Samples

Rainfall samples were collected on a monthly basis from twelve monitoring stations during the summer and fall of 1970. The locations of the monitoring stations are illustrated in Figure II and described in detail in Table III.

Data for the monthly samples collected from June to October, inclusive, are summarized in Appendix C, as well as a schematic of an actual monitoring station.

FIGURE II

LOCATION OF RAIN MONITORING STATIONS

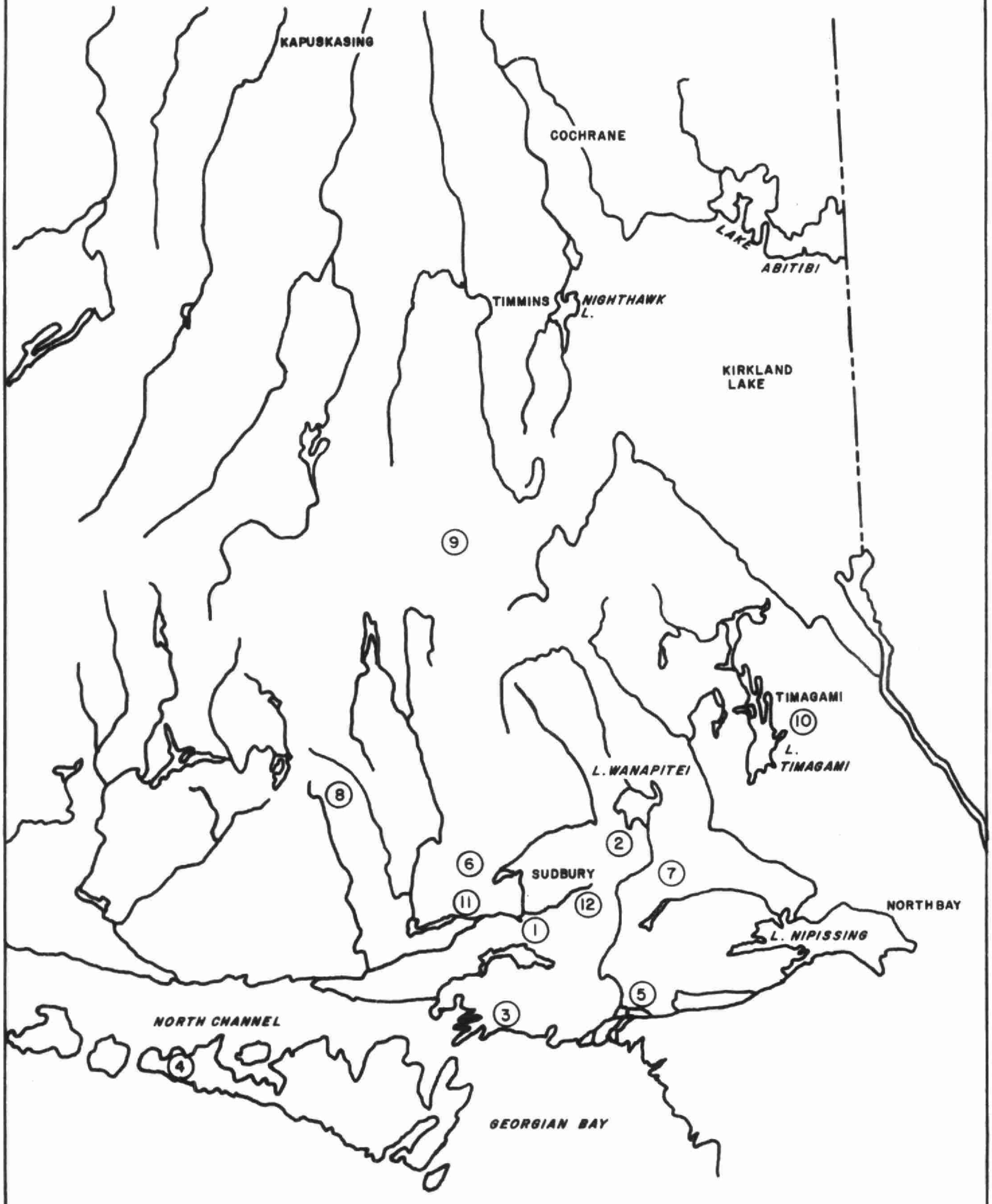


TABLE III

DETAILED DESCRIPTION OF RAIN MONITORING STATION LOCATIONS

Lake Penage	In an open field east of the Ontario Lands & Forests cabin on the north shore 300 yards east of Blanchard's Marina near Highway 549.
Skead	In an open area on top of a hill at Chief Ranger's Headquarters, Ontario Lands & Forests, Marrey Bay, Lake Wanapitae, near the village of Skead.
Killarney	In an open field in the Killarney Provincial Park at George Lake near Highway 637.
Meldrum Bay	On a gravel point east of the general store in the village of Meldrum Bay on the west tip of Manitoulin Island.
Jamot	In a small open area next to the Ontario Lands & Forests ranger station on the shore of French River near the village of Alban on Highway 64.
Windy Lake	In a small opening located beside Ontario Lands & Forests headquarters at Windy Lake Provincial Park near the town of Levack.
Stinson	In a small clearing near the Ontario Lands & Forests temporary headquarters adjacent to Highway 17 east of Sudbury.
Township O	Beside the Ontario Lands & Forests firetower cabin north of the town of Massey, latitude, 46^{o} 52' N, Long., 82o 24' W.
Gogama	In a clearing near the Ontario Lands & Forests headquarters in Gogama.
Temagami	On the roof of the Ontario Lands & Forests warehouse in the town of Temagami.
McFarlane Lake	Near the Ontario Lands & Forests air base on the north shore of Mc Farlane Lake south of the city of Sudbury

DISCUSSION

Lake Sampling Program

Data are presented for some 110 lakes in the Sudbury basin and surrounding area. Nineteen of these lakes are located south-east, 37 north-east, 40 south-west and 14 north-west of Sudbury, covering an area from Espanola to North Bay and from the French River to Cobalt.

All lakes had measurable sulphate (SO_4) concentrations, and 81 had measurable metal concentrations of which 75 had measurable nickel or copper concentrations. No metal concentrations were recorded for 26 lakes and data were not available for three lakes. Ranges of concentrations recorded, excluding all lakes with known liquid industrial waste input, are summarized in Table IV.

Table IV

Ranges of metal concentration in Lakes

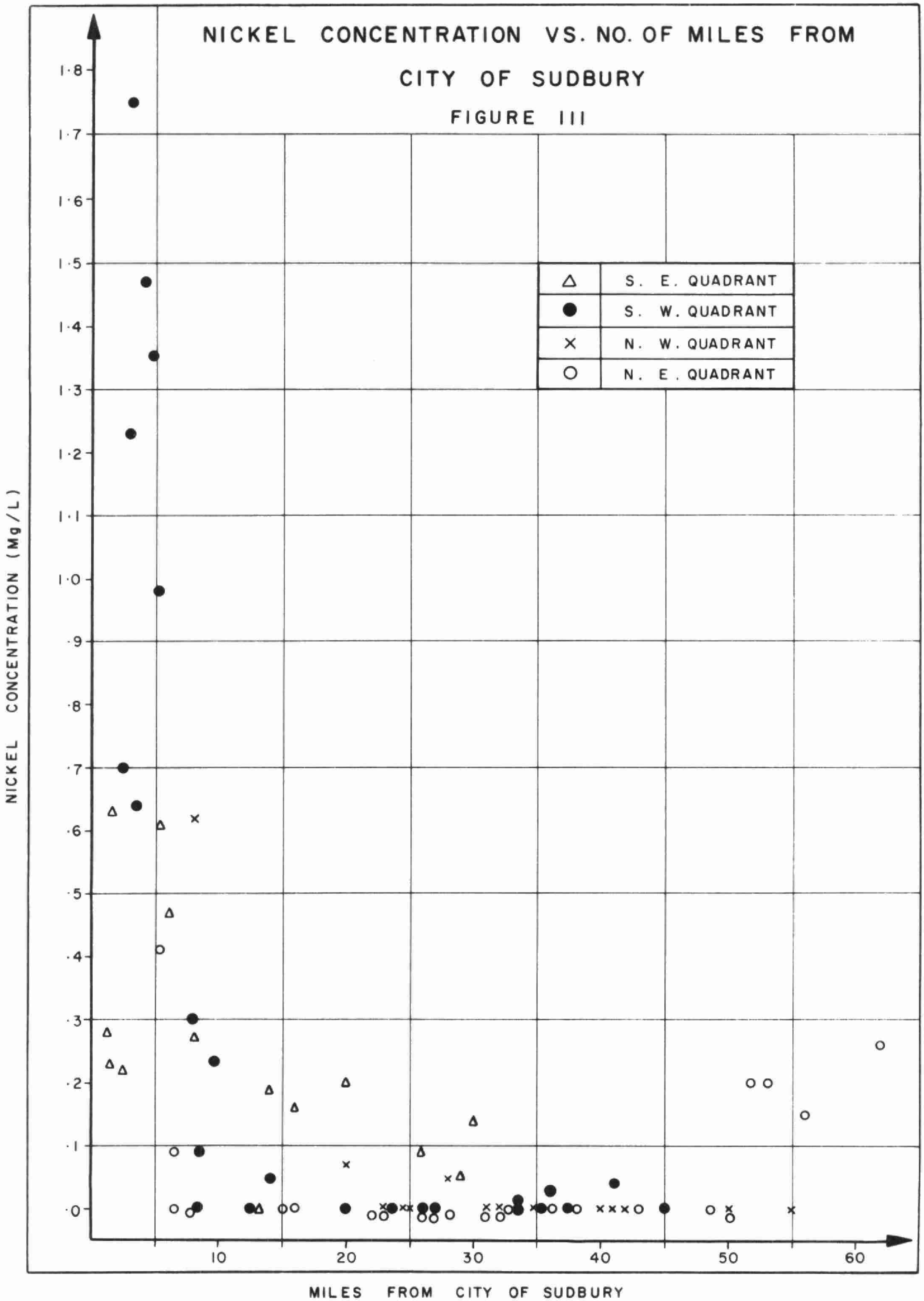
Contaminent	Maximum Concentration (ppm)	Minimum Concentrations (ppm)
SO_4	73.0	8.0
Nickel as Ni	2.05	0.0
Copper as Cu	.76	0.0
Iron as Fe	3.1	0.0
Zinc as Zn	0.16	0.0

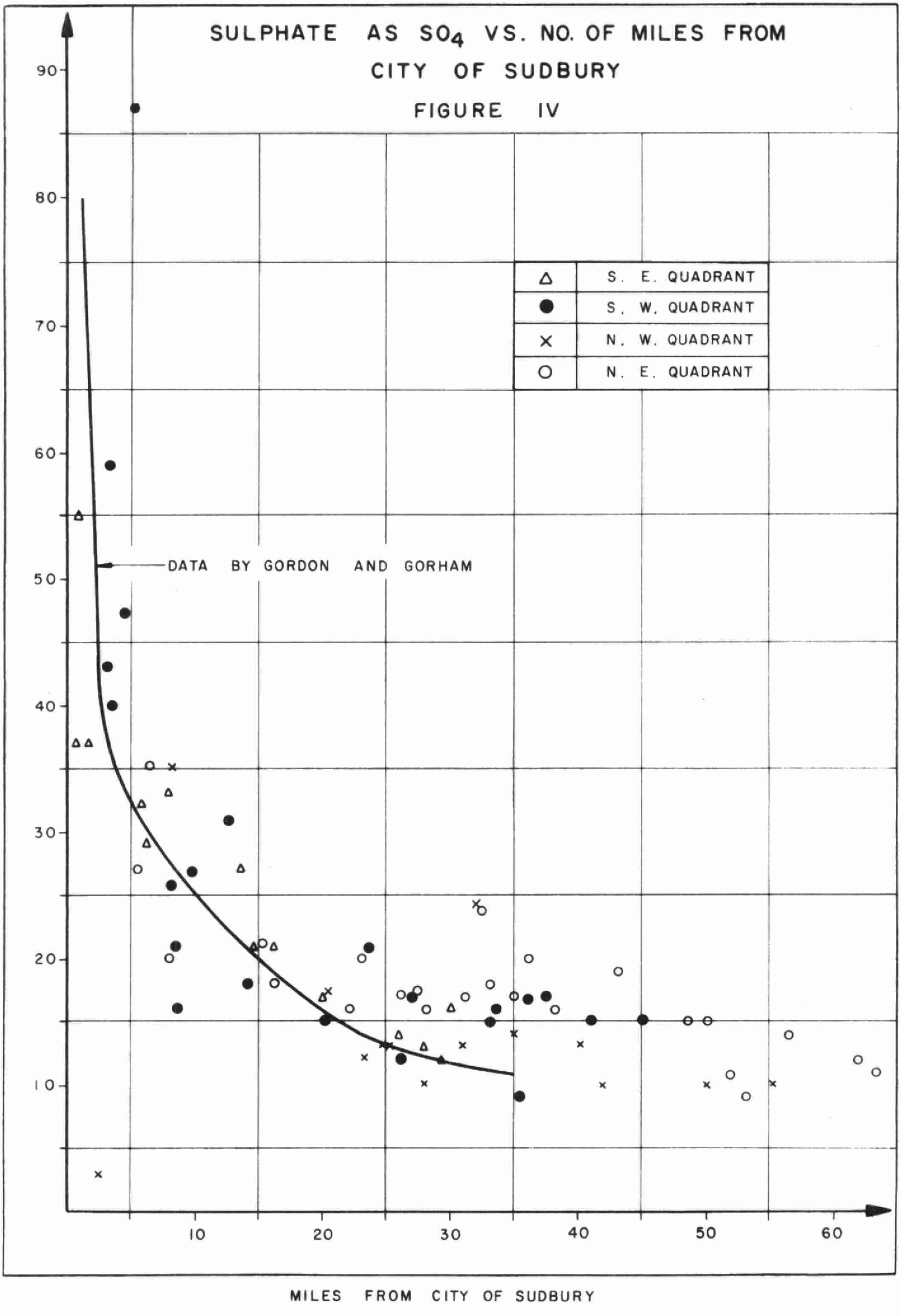
The highest concentrations except for zinc were recorded for lakes located in the southwest part of Sudbury, namely, Charles Lake, Middle Lake, Hannah Lake, Still Lake and Robinson Lake. None of these lakes have liquid industrial waste input. The highest concentrations for zinc were reported for lakes in the Temagami - Cobalt area.

Concentrations of nickel and sulphate (SO_4) as a function of the air distance from Sudbury are graphically detailed in Figures III and IV. This graphical representation would indicate that both nickel and sulphate concentrations decrease with distance from the city of Sudbury, and would indicate that lakes with no external interference should have a nickel concentration of essentially 0.0 ppm and a sulphate concentration of 10-15 ppm.

One unexpected anomaly exists in the data presented in Figure III. Lakes in the Temagami area, including Tomiko, Red Cedar, Manan, Jumping Caribou and Temagami have nickel concentrations higher than expected, in comparison with other lakes closer to Sudbury. The same lakes contained essentially no copper, relatively low quantities or iron and between 0.10 and 0.20 ppm of zinc. No explanation for this phenomenon is available at this time. With reference to Figure III, and IV, excluding the lakes in the Temagami area, it can be seen that both the nickel and sulphate concentrations decrease with distance from the city of Sudbury, <u>independent of direction</u>.

The same trend in decreasing sulphate levels with distance from the city of Sudbury was noted by E. Gorham and A.G. Gordon in an investigation of small pothole lakes in the Sudbury area, completed in 1963.


NICKEL CONCENTRATION VS. NO. OF MILES FROM CITY OF SUDBURY
FIGURE III
S. E. QUADRANT
S. W. QUADRANT
N. W. QUADRANT
N. E. QUADRANT
NICKEL CONCENTRATION (Mg/L)
MILES FROM CITY OF SUDBURY
1·8
1·7
1·6
1·5
1·4
1·3
1·2
1·1
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
·0
10
20
30
40
50
60


SULPHATE AS SO_4 VS. NO. OF MILES FROM
CITY OF SUDBURY
FIGURE IV
S. E. QUADRANT
S. W. QUADRANT
N. W. QUADRANT
N. E. QUADRANT
DATA BY GORDON AND GORHAM
SULPHATE AS SO4 (Mg/L)
90
80
70
60
50
40
30
20
10
10
20
30
40
50
60
MILES FROM CITY OF SUDBURY

Insufficient data are available at this time to define seasonal trends in lake water quality or yearly trends. Compounding this problem is the influence of abnormal high spring rainfall for 1970 and the strike at both the International Nickel Company of Canada, Limited and Falconbridge Nickel Limited during the summer of 1969. Therefore, no attempt will be made to compare data for individual lakes as an attempt to define trends.

One of the primary objectives of this investigation was to determine changes in lake water quality over the past decade. However, studies by Gordon and Gorham were for small pothole lakes as opposed to the larger lakes sampled during this investigation, thus negating the possibility of direct comparison. Data are available to show that the ph and SO_4 concentration in Lake Wanapitei, located north-east of Sudbury, have remained relatively constant for the period 1960 to 1970 at a pH of 7.2-7.4 and a sulphate concentration of 15 to 20 ppm (lake has estimated retention period of less than 5 years and as such is considered a lake with a relatively high flushing rate).

In reality, insufficient data are available to accurately determine changes in water chemistry over the past two decades for those lakes where there has been a loss of good Lake Trout fisheries.

Snow Sampling Program

A total of twenty-one snow samples were collected throughout the Sudbury area during the winter of 1969-1970. The results reported characterize the quality of the surface snow samples, but in no manner, can be used to determine quantitatively the total amount of metal per acre per winter. To complete such a calculation would require an expansion of the program in terms of total samples collected, an improvement in sample collection devices and a close monitoring of wind direction and velocity. However, these sample results can be used to qualitatively assess contamination levels, extent of zone of influence and zone of major influence.

All snow samples contained detectable quantities of iron, fourteen contained detectable quantities of nickel, and fifteen a significant amount of copper. The concentrations ranged from 0.06 to 84 ppm iron, 0.00 to 16.8 ppm nickel and from 0.00 to 4.4 ppm of copper. For reference purposes, O.W.R.C. effluent objectives are 17 ppm iron (mg/1), 1 ppm nickel and 1 ppm copper. It must be concluded therefore, that the contamination levels are significant, and that the melted snow runoff, contaminated by fallout from the atmosphere, is contributing to water pollution of the lakes and streams in the area under investigation.

The most highly contaminated samples, six of which were contaminated to such an extent as to be unacceptable for discharge to a watercourse in terms of O.W.R.C. effluent objectives, were collected in a triangular area with Sudbury, Coniston and Lake Wanapitei each representing an apex of the triangle.

However, as discussed above, all samples contained some metal values. It is hypothesized therefore, based on the limited data available, that the zone of influence is extremely large (one sample collected at Killarney Bay over 40 air miles from Sudbury had 0.13 ppm of copper and 0.76 ppm or iron), possibly extending to the zone of influence created by industrial operations in other areas. It is further hypothesized that the major influence is relatively small in comparison, covering an area of approximately 350 square miles and including Sudbury, Coniston, Garson, Falconbridge, Skead and the lower end of Lake Wanapitei.

In comparing total and dissolved metal concentrations, it would appear that most of the metals are present in particulate form and it is assumed that the metals were emitted to the atmosphere in a similar form i.e, as particulates. A definitive analysis to determine the molecular structure of the particles has not been completed, and at this time it can only be hypothesized that the metals may be present as a combination of oxides, sulphides and elemental metals (based on metallurgical operations involved). Considering the pH of the melted snow samples (3.8 - 6.3), it is reasonable to assume that a large portion of the metal values noted will end up in the runoff in dissolved form, contributing to the pollution load in the receiving streams.

Rainfall Sampling Program

Results of the rainfall monitoring program are detailed in Appendix C. These results covering an area from Manitoulin Island to Temagami and from Gogama to Stinson can be used qualitatively, in a manner similar to the snowfall samples, and generally they reflect similar conclusions.

The highest concentrations of copper, nickel, zinc, and iron recorded at the twelve sampling stations are summarized in Table V. The maximum recorded concentrations were 0.24 ppm of copper, 0.236 ppm of nickel, 0.380 ppm of zinc and 0.900 ppm of iron.

TABLE V

Maximum Rainfall Concentrations

	Copper as Cu (ppb)	Ni (ppb)	Zn (ppb)	Fe (ppb)
June	140 (7)	60 (2)	340 (2)	90 (2)
July	120 (7)	80 (12)	360 (12)	123 (2)
August	240 (12)	236 (12)	380 (12)	900 (12)
September	80 (12)	35 (12)	184 (2)	72 (2)
October	120 (12)	72 (2)	152 (2)	140 (2)

(2) Skead

(7) Stinson

(12) McFarlane Lake

NOTE: ppb = mgm/1000 l

With reference to Table V, it can be seen that 18 of the 20 maximum concentrations including all maximum concentrations for Ni, iron and zinc were recorded at either Skead or McFarlane Lake.

Data collected from the Sudbury area rainfall monitoring program are compared with data published by Mr. A.L. Lazrus et al. in Table VI.

TABLE VI

Comparison of Rainfall Data

Contaminant	1 (ppm)	2 (ppm)	3 (ppm)	4 (ppm)
Zinc	0.107	0 - 0.3	.024 - .38	0.025
Copper	0.021	0.05 - 0.15	0.004 - .24	0.014
Nickel	0.004	0 - .002	0 - .236	0.002
Iron	-	0 - .019	0 - .90	-

(1) average concentration for all rainfall samples collected from 32 stations located throughout the U.S.A. for the period September 1969 - January 1970.

(2) rainfall concentrations recorded at Sault Ste. Marie, Michigan from September 1966 - January 1967.

(3) concentrations recorded during Sudbury area rainfall monitoring program, June - October 1970.

(4) average concentrations for rainfall samples collected throughout the Province of Ontario.

Although insufficient data are available to draw conclusions, it may be significant that maximum concentrations recorded at Sudbury for zinc and nickel are considerably above maximum values reported for Sault Ste. Marie, Michigan, another industrial centre, and the nickel and copper concentrations are an order of magnitude above the average for the whole of the U.S.A. and for Canada.

The results of the rainfall sampling program completely substantiate the hypotheses made based on the snowfall sampling program, in that:

(1) The immediate Sudbury area would appear to be the zone of major influence while the total size of the zone of influence is extremely large and essentially undefined at this time.

(2) Assembled data indicates that metal concentrations in rainfall are of the same order of magnitude as metal concentrations in area lake waters. Thus rainfall contaminated by passage through the atmosphere must be contributing to water pollution of the lakes and streams in the area under investigation.

CORRELATION OF DATA

Data have been presented on the lake water, snowfall and rainfall monitoring programs. The following is an attempt to interrelate this data and data compiled by Mr. B.R. Dreisinger M.F on atmospheric sulphur dioxide levels in the Sudbury area.

Figure V represents a summation of mean SO_2 concentrations recorded at monitoring stations in the Sudbury area between 1964 and 1968. The data presented are divided into four zones ranging from heavy to very light mean SO_2 concentrations. The heavy zone is in the immediate Skead area, the medium zone covers an area including Sudbury, Coniston and Lake Wanapitae, while the light and very light zones cover areas extending up to almost 50 miles from Sudbury. It should be noted that these are not maximum concentrations. For example, a mean SO_2 concentration of 0.0075 ppm as compared to the maximum half-hour concentration of 0.77 ppm has been recorded as Grassy Lake, 40 miles from Sudbury. This must be interpreted as meaning that, depending on wind conditions, detectable atmospheric SO_2 levels could be recorded at distances considerably greater than 40 miles from Sudbury.

Table VII is a correlation of all data based on the zones presented in B.R.Dreisinger's work. From an inspection of the table, it would appear that contaminant levels in snow samples, rainfall samples, lake samples and mean SO_2 levels in the atmosphere all show the same decreasing trend with distance from Sudbury while the lake pH increases with distance from the Sudbury complex.

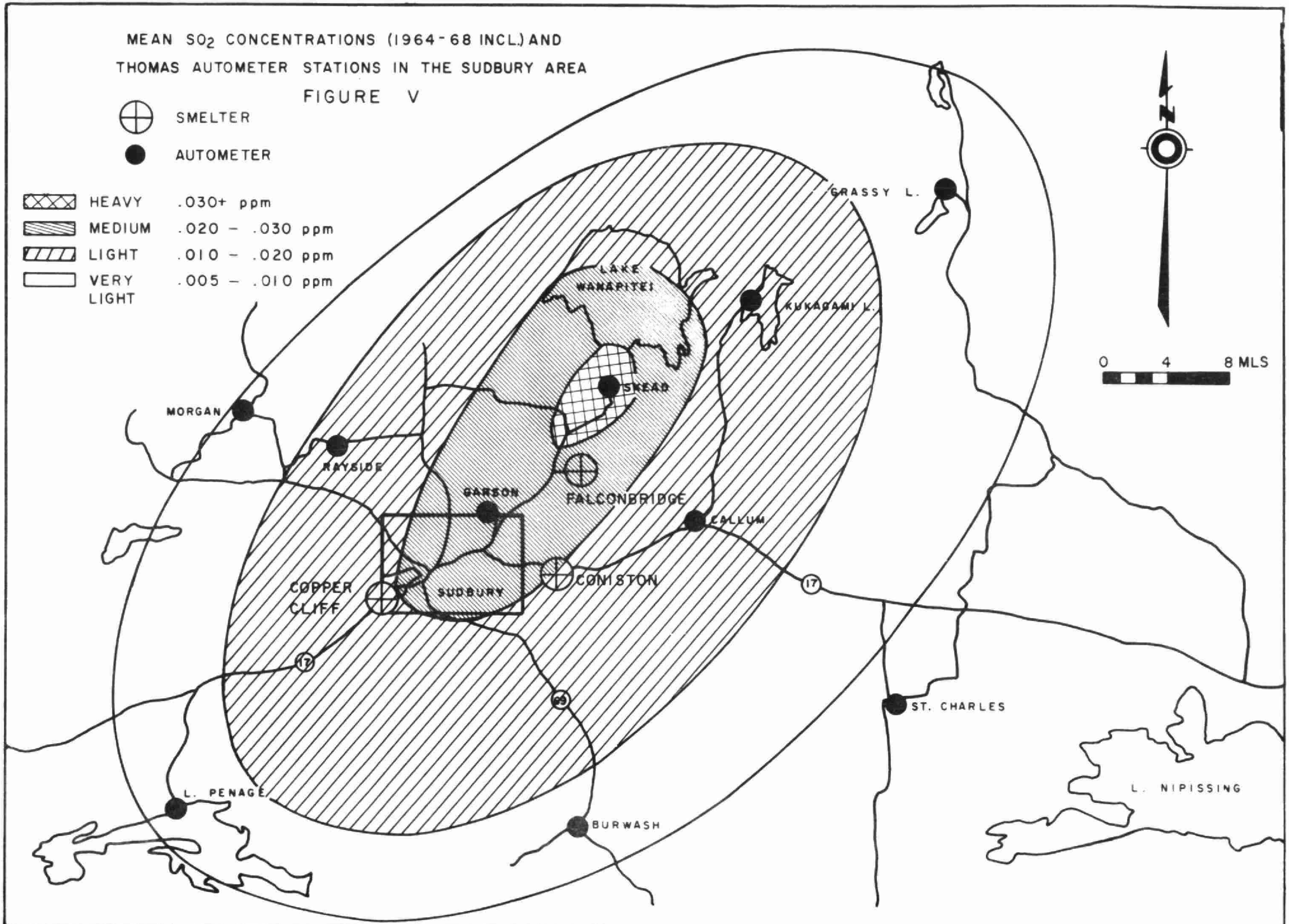

MEAN SO_2 CONCENTRATIONS (1964-68 INCL.) AND
THOMAS AUTOMETER STATIONS IN THE SUDBURY AREA
FIGURE V
SMELTER
AUTOMETER
HEAVY .030+ ppm
MEDIUM .020 - .030 ppm
LIGHT .010 - .020 ppm
VERY LIGHT .005 - .010 ppm
0 4 8 MLS
N
GRASSY L.
LAKE WANAPITEI
KUKAGAMI L.
SKEAD
MORGAN
RAYSIDE
GARSON
FALCONBRIDGE
CALLUM
COPPER CLIFF
SUDBURY
CONISTON
17
69
ST. CHARLES
L. NIPISSING
L. PENAGE
BURWASH

TABLE VII

Comparison of Data (1970 - November Data)

Zone / Mean SO_2	Rainfall Samples Cu	Rainfall Samples Ni	Rainfall Samples Zn	Snow Samples Cu	Snow Samples Ni	Snow Samples Fe	Lake Samples Cu	Lake Samples Ni	Lake Samples Fe	Lake Samples pH	Lake Samples SO_4	
1 / .03+				-	-	-	-	-	-	-	-	Max.
				-	-	-	-	-	-	-	-	Min.
				-	-	-	-	-	-	-	-	Ave.
2 / .02-.03				8.0	16.8	84.0	0.53	1.73	0.40	6.4	73	Max.
				.98	.67	5.6	0.03	0.45	0.15	4.2	26	Min.
				4.5	7.2	47.8	0.28	1.18	0.22	5	50	Ave.
3 / .01-.02				0.2	0.24	2.6	0.33	0.62	0.45	7.0	55	Max.
				0	0	0.3	0	0	0	4.3	17	Min.
				0.15	0.06	1.5	0.04	0.15	0.14	5.5	28	Ave.
4 / .005-.01				1.07	0.32	11.2	0	0.09	0.20	6.8	27	Max.
				0	0	0.06	0	0	0	4.6	19	Min.
				0.20	0.07	3.1	0	0.02	0.06	6.1	23	Ave.
5 / <.005				0.13	0.04	0.76	0.01	0.09	0.25	7.2	17	Max.
				0	0	0.06	0	0	0	4.7	9	Min.
				0.04	.03	0.27	0	0	0.1	6.4	13	Ave.

It can also be seen that the magnitude of the contamination in snow and rainfall samples is at least comparable to the quality of lake water samples indicating that such contamination levels would have an influence on the receiving watercourse.

With reference to Mr. Dreisinger's data, it can be seen that the isoconcentration lines are egg shaped with the major axis lying in a northeast-southwest direction from Sudbury as would be expected considering the prevailing wind directions. Similarly, it is expected that if sufficient snow and rainfall samples were collected, comparable isoconcentration lines could be constructed, since the pattern would again be determined in part by the prevailing wind direction.

The areas which receive the greatest impact from atmospheric fallout (northeast-southwest quadrants) are the same areas where the greatest problems with declining fisheries exist (Table IX). In particular, OSA, Killarney, George, Lumsden, Johnie, Bell, Brushcamp, Norway, Broker, Tyson, and Nellie in the southwest and Kukagami, Donald, Maskinonge, Matagamasi and Chiniguichi in the northeast. Further, all lakes which have experienced a loss of fish populations or where fish production has reached a level of concern lie within zone III or in areas experiencing 0.010 ppm or greater mean SO_2 concentrations in the atmosphere. The only exceptions, lakes lying some distance from Sudbury in a south-southwest direction would probably be included in the zone if the mean SO_2 concentrations reflected yearly mean concentrations and not just summer conditions (prevailing wind is from the north during the winter).

ASPECTS OF DECLINING FISH POPULATIONS

A. Effect of Heavy Metal Concentrations on Fish

It is difficult to assign a specific concentration at which a metal becomes toxic to fish. Much of the data reported in the literature is of questionable value owing to a failure to record other parameters such as hardness and pH in the performance of necessary tests. Also, lethal concentrations vary with the type of assay and the test species. In addition, the effects of at least some metals are additive. For example, a sublethal concentration of zinc plus a sublethal concentration of copper in the same waters may produce a lethal effect on fish depending on component concentrations (Lloyd, 1962). A summary of some of the available data on toxicity of metals to fish is presented in Table VIII.

Exposure to some metals over an extended period of time at levels well below the toxic concentration, for that metal, may lead to damage in the aquatic ecosystem since some metals are concentrated by feeding relationships and retention in the biota.

B. Effect of pH on Fish

As for metals, considerable research on the response of fishes to increased hydrogen ion concentration is of questionable value because of failure to recognize other parameters. As pointed out by Lloyd and Jordan (1964), the concentration of carbon dioxide is extremely critical in comprehending the effect of low pH on rainbow trout. By extrapolation, they suggest that rainbow trout could be adversely affected by pH less than 6.0 if the carbon dioxide concentration is high.

TABLE VIII

Summary of the toxicity of metal concentrations on fish.

Metal	Concentration mg/l	Remarks	Source
Zinc	0.56	7-day TLm -rainbow trout;soft water	Lloyd, 1961
Zinc	0.60	III - salmon parr; soft water.	Sprague, 1964
Zinc	0.088	50% reduction in number of eggs laid-fathead minnows; hard water.	Brungs, 1969
Zinc	0.78	96-hr. TLm-fathead minnow; soft water	Pickering, 1966
Copper	0.048	III - salmon parr; soft water.	Sprague, 1964
Copper	0.022	96-hr. TLm-fathead minnow;soft water.	Pickering, 1966
Copper	0.011-0.018	mortality and re-productive failure; fathead minnow.	Mount, 1969
Cadmium	± 0.01	7-day TLm-rainbow trout;soft water, preliminary evaluation/	Ball, 1967
Cadmium	1.05	96-hr. TLm-fathead minnow;soft water.	Pickering, 1966
Nickel	4.58	"	"
Lead	5.58	"	"

(96-hr.) (7-day) TLm - concentration producing 50% mortality in(96 hours) (7 days).

III = incipient lethal level

Free carbon dioxide is often high in lakes of the Precambrian Shield since pH is relatively low. Bishai, (1962) cites an incipient lethal pH to Atlantic salmon and brown trout as between 6.0 and 6.2. Further, Bishai claims that during the first few weeks of post-egg development, salmon are unable to sense pH and high CO_2 in the environment. Johnson, Michalski and Christie (1970) and Conroy (1970) showed that reduced pH from acid mine wastes in the Elliot Lake area caused a reduction in primary productivity, and standing crops of phytoplankton and zooplankton. Johnson et al suggest that the reduction in primary production was associated with the effect of low pH in reducing the availability of inorganic carbon. Either indirectly (through the food chain) or directly, the depressed pH conditions of the lakes affected the abundance and distribution of fishes. Lake trout were characterized by poorer condition and walleye populations disappeared (Conroy, 1970) when lake pH values were approximately 5.5. Similar results were reported by Beamish, 1970 working on white sucker populations in lakes southwest of Sudbury. A dwarf population of suckers in Lumsden Lake was compared with a "normal" population in an adjacent lake (George Lake). Beamish suggested that low pH in the former lake was affecting the feeding behavior of the suckers. His research failed to reveal a significant difference between the zooplankton and bottom fauna of the lakes. However, laboratory testing showed that white suckers responded to depressed pH conditions by arresting their feeding habits. Subsequent weight losses were observed.

C. Combined Effects of pH and Heavy Metals

The hydrogen ion concentration (pH) is a master variable in the abiotic aquatic environment since, to a large extent, it controls the solubility of chemical species.

A direct relation exists between the equilibrium concentration of the soluble phase of heavy metals and the hydrogen ion concentration, i.e. at decreased pH, metals are more soluble. Heavy metals are more toxic in the soluble phase than in the solid phase, especially in the lake environment where lack of circulation allows the solid phase to be incorporated into bottom sediments where the metal is likely to be directly toxic to fish. It may, however, be available for biochemical transformations and subsequent accumulation via the food chain.

It has been reported that fish which can tolerate a pH as low as 4.8 die in water of pH 5.5 which contains 0.9 mg/l iron, (Minkina, 1946 and Brandt, 1946, references not seen; see McKee and Wolf, 1963).

D. Data on Fish Populations in the Sudbury Area

Although the information presented on declining fish populations is qualitative (Table IX), it is obvious that problems do exist. Lake Trout fisheries in Wavy, White Oak, Millerd, Long and Ramsey Lakes, located just south of Sudbury disappeared as early as 1945. There is documented evidence to show that good Lake Trout fisheries existed in lakes southwest of Sudbury, including OSA, Killarney, George, and Lumsden Lakes as recently as 1955. Netting surveys in 1969 indicated a complete loss of these fisheries. Similarly, fisheries located northeast of Sudbury, in Kukagami, Donald, Maskinonge, Matagamasi, Chiniguichi and Alphretta have either been lost completely or in part.

It is a fact that some lakes in the Sudbury area have a pH lower than is associated with normal lake water and many also have significant metal concentrations, or sulphate concentrations exceeding normal levels. It is hypothesized that a correlation may exist between lowering of pH, changes in water chemistry and the geology of the lake basin. Since many of these lakes are in remote areas, and the geology of the lake basin must be considered constant, it must be assumed that changes in lake chemistry is a direct result of input from the atmosphere.

To date, the mechanism by which fisheries are affecte is unknown. However, a conservative estimate of the result is a loss of 25,000 acres of Pickerel water and 17,000 acres of Lake Trout water. One would not expect a change of this magnitude due to angling pressure alone, especially with Pickerel fisheries.

TABLE IX

Data on Fish Populations

Lake	Comments
OSA*	complete loss of Lake Trout
Killarney	"
George	"
Lumsden	"
Johnie	"
Bell	"
Brushcamp	"
Norway	"
Broker	"
Tyson	"
Nellie*	"
Wavy	- minimal sport fishery - no Lake Trout
White Oak	"
Millerd*	"
Long	"
Ramsey	"
Kukagami	Trout fishery of concern
Donald	"
Maskinonge	"
Matagamasi	no Trout or Pickerel
Chiniguichi	no Lake Trout
Alphretta	shows signs of deterioration
Clearwater	no fish
Middle	no fish
Hannah	no fish
Robinson	no fish
St. Charles	no fish
Washigami	Pickerel fishing declining
Frenchman	Trout fishery declining
Nepahwin	no fish

Note: * Fall, 1969, data -- all other data - summer of 1970

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APPENDIX A

Lakewater Sample Data

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
1	Pogamasing Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	6	0.0	0.0	.1.	6.2	7.0	9	-	20	7	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	-	0.0	0.0	0.0	7.2	7.0	10	-	22	8	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
2	Onaping Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	6	0.0	0.0	.10	5.9	7.1	9	-	24	8	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	-	0.0	0.0	0.0	7.4	6.7	13	-	20	7	0.0
		1970	30	5	0	0	0	6.8	6.5	12	-	16	7	0.0
3	Geneva Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	20	6	0.03	0.0	.25	6.1	7.0	14	-	8	7	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	-	0.0	0.0	0.0	7.3	6.7	24	-	18	6	0.0
		1970	30	10	0	0	0	6.7	6.7	10	-	34	6	0.0
4	Windy Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	29	4	0.0	.01	.10	-	6.5	20	-	-	7	-
		1969	40	6	0.0	0.0	.13	6.0	7.1	14	-	20	6	-
		1970	50	5	0.0	0.0	0.0	6.1	6.0	13	14	16	7	-
		1970	50	5.7	0	0	0	6.6	6.3	12	-	20	7	.0
		1970	30	6	0	0	0	6.7	6.6	10	-	20	5	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
5	Whitewater Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	130	18	1.2	.10	.27	-	7.4	45	-	-	33	-
		1969	170	24	0.0	.35	.45	6.8	6.5	55	-	90	39	-
		1970	165	27	.02	0.0	3.1	6.7	6.6	51	51	96	45	-
		1970	100	16	.62	0	.3	7.2	6.9	35	-	64	29	.14
		1970	160	26	.57	0	0	7.8	6.3	51	-	104	39	0.0
6	Nelson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	50	5	0.01	0.0	.10	5.2	6.7	19	-	20	4	-
		1970	40	6	.04	0.0	0.0	6.2	6.3	16	16	28	5	-
		1970	70	6	0.0	0.0	0.17	-	6.0	14	-	40	4	.05
		1970	20	6	0	0	0	6.1	5.9	18	-	20	7	.02
7	Bigwood Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	20	5	0.04	0.0	.20	5.2	6.8	15	-	18	5	-
		1970	60	5	0.0	0.0	0.0	5.5	5.6	14	14	16	14	-
		1970	25	-	0.0	0.0	0.0	6.1	5.7	13	-	16	3	0.0
		1970	20	6	0	0	0	5.7	5.8	15	-	18	4	.02
8	Shakwa Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	5	0.0	0.0	.10	6.1	7.1	9	-	20	7	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	-	0.0	0.0	0.0	7.3	6.9	10	-	12.0	7	0.0
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
9	Vermillion Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	77	11	.15	.01	.2	-	6.8	17	-	-	18	-
		1969	50	12	0.0	0.0	.53	6.7	7.2	21	-	36	18	-
		1970	70	10	0.0	0.0	0.0	6.7	6.5	15	17	32	19	-
		1970	55	6.5	0.07	0	.17	6.7	6.8	17	-	30	12	.05
		1970	70	13	0	0	.1	6.6	6.6	22	-	40	14	0.0
10	Ministic Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	5	0.0	0.0	.13	6.4	7.1	11	-	18	6	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	35	3.5	.05	0	.12	6.6	6.6	10	-	24	6	-
		1970	20	4	0	0	0	6.4	6.4	23	-	14	5	0.0
11	Venetian Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	20	6	0.0	0.0	.20	5.9	7.1	15	-	18	5	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	-	0.0	0.0	0.0	6.6	6.5	13	-	20	5	0.0
		1970	20	5	0	0	0	6.3	6.4	16	-	16	5	0.0
12	Sinaminda Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	6	.01	0.0	.25	6.2	7.0	9	-	8	8	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	-	0.0	0.0	0.0	7.2	7.0	10	-	18	6	0.0
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
13	**Halfway Lake**	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	-	0.0	0.0	0.0	7.2	7.0	10	-	18	6	0.0
		1970	30	7	0	0	0	6.8	6.6	12	-	26	9	0.0
14	**Michaud Lake**	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	35	-	0.0	0.0	0.0	5.8	5.3	13	-	32	5	0.0
		1970	20	5	0	0	0	5.3	5.6	15	-	16	3	.04

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
1	McFarlane Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	80	18	.03	.01	.15	7.0	6.4	33	-	66	23	-
		1970	100	7	.3	.07	.90	7.0	6.2	10	-	26	16	-
		1970	100	16	.47	0.0	.07	-	7.1	29	-	60	20	.05
		1970	80	18	.14	0	0	6.7	6.3	31	-	74	23	0.0
2	Crowley Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	8	.27	0.0	.33	5.2	5.9	33	-	28	4	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	90	10	.25	0	0	5.5	6.1	23	-	34	4	0.0
3	White Oak Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	5	.06	0.0	.20	4.2	5.3	26	-	26	3	-
		1970	45	6	.09	0.0	0.0	5.0	5.9	25	26	24	3	-
		1970	40	5	.19	0	.17	4.9	5.0	21	-	20	3	.07
		1970	50	5	.15	0	0	4.3	6.9	21	-	20	3	.16
4	Bird Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	5.5	.14	0	.3	6.7	6.0	16	-	18	5	.12
		1970	30	4	0	0	0	6.4	6.3	20	-	18	4	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
5	Trout Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	6	0.0	0.0	.10	6.2	6.7	17	-	22	12	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	65	4.8	.09	.01	.38	7.3	6.8	14	-	34	9	-
		1970	50	6	0	0	0	6.0	6.5	17	-	20	7	0.0
6	Nepewassi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	8	.01	0.0	.10	6.9	6.6	20	-	26	20	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	90	5.4	.20	.01	.52	7.4	6.7	17	-	34	11	-
		1970	40	7	0	0	0	7.2	6.5	20	-	26	11	0.0
7	Bethel Lake	1963	-	17	-	-	-	-	6.9	63	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	180	18	.22	0.0	.30	-	8.1	13	-	76	50	.05
		1970	200	17	.0	0	0	7.7	7.2	20	-	72	46	0.0
8		1963	-	21	-	-	-	-	5.8	90	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
9	Elbow Creek	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	80	7.0	.16	0.0	.27	6.0	6.6	21	-	34	10	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
10	Millerd Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	45	8	0.0	0.0	.20	6.3	6.8	27	-	32	10	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	6	.06	0	0	5.8	6.3	21	-	26	7	.01
11	Ramsey Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	120	18	.23	0.0	0.0	-	7.2	37	-	70	15	.02
		1970	180	16	.25	0	0	6.8	7.1	41	-	62	14	0.0
12	Nepahwin Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	140	16	.28	0.0	0.0	-	7.8	36	-	62	12	.02
		1970	170	19	.14	0	0	6.6	7.1	38	-	66	12	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
13	Richard Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	90	14	.61	0.0	.13	-	7.2	32	-	54	16	.08
		1970	140	12	.32	0	0	6.7	6.7	37	-	54	15	0.0
14	Still Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	380	32	.63	0.0	.46	-	6.8	55	-	128	18	.11
		1970	-	-	-	-	-	-	-	-	-	-	-	-
15	Ratter Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	90	5.1	.05	0.0	.84	7.0	7.3	13	-	50	11	-
		1970	60	8	0	0	0	6.1	6.8	15	-	-	-	0.0
16	Hugel Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	80	8.2	.05	0.0	.53	7.1	6.8	12	-	36	20	-
		1970	60	10	0	0	0	6.1	6.8	17	-	34	20	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS	CALCIUM	NICKEL	COPPER	IRON	pH		SULPHATE		HARD	ALK	ZINC
			Total	as Ca	as Ni	as Cu	as Fe	Field	Lab.	as SO_4	Oxid.	$CaCO_3$	$CaCO_3$	
17	Raft Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	80	10	0.11	0.0	0.0	5.9	5.6	26	-	34	3	0.0
18	Brodill Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	=	-	-	-	-	-	-	-	-	-
		1970	90	7	0.15	0.0	0.0	5.6	6.2	21	-	26	3	0.02
19	Red Deer Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	10	0.09	0.0	0.0	6.7	6.8	24	-	38	13	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
1	Frenchman Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	80	9	0.0	0.0	.15		5.3	<5		-	5	-
		1969	30	7	0.0	0.0	.15	4.4	6.4	26	-	26	3	-
		1970	45	5	.04	0.0	.04	4.8	5.0	21	21	22	5	-
		1970	35	-	0.0	0.0	0.0	5.1	5.1	21	-	28	2	.03
		1970	20	6	0	0	0	5.0	5.6	21	-	20	3	.05
2	Alphretta Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	6	0.0	0.0	.10	5.3	6.5	20	-	20	4	-
		1970	40	6	.04	0.0	0.0	5.7	8.2	17	17	26	6	-
		1970	25	-	0.0	0.0	0.0	6.6	6.0	17	-	18	5	0.0
		1970	20	5	0	0	0	5.0	5.7	18	-	20	3	.01
3	Chiniguchi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	6	0.0	0.1	.15	4.0	4.9	24	-	22	3	-
		1970	40	5	0.0	0.0	.04	4.5	4.6	19	19	22	3	-
		1970	45	-	0.0	0.0	0.0	5.1	4.7	18	-	18	1	0.0
		1970	20	6	0	0	0	4.3	4.9	18	-	20	3	.02
4	Matagamasi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	6	0.0	0.0	.15	4.5	5.0	21	-	22	3	-
		1970	50	5	.02	0.0	.04	4.6	4.9	20	20	22	4	-
		1970	60	-	0.0	0.0	0.0	4.0	4.8	17	-	14	1	.02
		1970	30	5	0	0	0	4.0	5.2	21	-	20	4	.01

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
5	Kukagami Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	6	0.0	0.0	.10	4.7	5.5	27	-	30	4	-
		1970	50	5	.04	0.0	0.0	5.3	7.0	22	22	22	4	-
		1970	55	-	0.0	0.0	0.0	6.2	6.0	17	-	20	5	.02
		1970	20	6	0	0	0	5.0	6.0	22	-	20	4	0.0
6	Garson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	3	0.05	0.0	.15	4.7	5.7	26	-	26	5	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	-	0.0	0.0	.10	5.0	5.4	20	-	24	2	-
7	Whitson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	35	9	.09	0.0	.20	4.2	9.7	35	-	32	3	-
		1970	55	9	.24	.07	0.0	5.2	5.0	35	35	42	5	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	9	.31	.03	0	4.4	6.1	33	-	32	2	-
8	Ashigami Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	85	9	.10	0.0	.15	-	6.2	5	-	-	5	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	0.0	.07	0.0	-	5.6	16	-	26	6	-
		1970	40	-	0.0	0.0	0.0	7.3	6.3	20	-	24	5	0.0
		1970	40	7	0	0	0	5.6	6.7	22	-	22	4	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS	CALCIUM	NICKEL	COPPER	IRON	pH		SULPHATE		HARD	ALK	ZINC
			Total	as Ca	as Ni	as Cu	as Fe	Field	Lab.	as SO_4	Oxid.	$CaCO_3$	$CaCO_3$	
9	Wanapitei Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	75	10	.02	0.0	0.0	6.4	7.1	16	16	36	19	-
		1970	75	-	-	-	.10	-	7.4	16	-	30	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
10	McCrea Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	90	9	.41	0.0	.3	-	5.4	27	-	44	3	.08
		1970	130	11	.57	0	0	5.2	5.0	37	-	40	2	.04
11	Capreol Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	6	0.0	0.0	.17	-	6.6	18	-	40	6	.03
		1970	20	6	0	0	0	6.0	6.1	21	-	20	5	.02
12	Rawson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	-	0.0	0.0	0.0	5.7	5.4	20	-	22	4	-
		1970	20	5	0	0	0	4.7	5.3	21	-	20	4	.02

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
13	Emerald Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	35	-	0.0	0.0	0.0	7.4	7.2	19	-	36	8	0.0
		1970	40	5	0	0	0	5.9	6.6	22	-	22	9	0.0
14	Wawiashkashi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	55	-	0.0	0.0	0.0	7.5	7.2	16	-	42	13	0.0
		1970	30	5	0	0	0	5.8	6.7	17	-	20	7	0.0
15	Donald Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	25	-	0.0	0.0	0.0	5.2	4.9	17	-	18	3	0.02
		1970	30	5	0	0	0	3.8	5.0	21	-	20	4	0.0
16	Maskinonge Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	-	0.0	0.0	0.0	5.8	5.9	24	-	20	3	.02
		1970	20	6	0	0	0	4.8	6.3	18	-	20	5	.02

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
17	Washagami Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	-	0.0	0.0	0.0	6.3	6.1	16	-	18	5	0.0
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	6	0	0	0	5.7	6.3	20	-	20	4	0
18	Murray Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	-	0.0	0.0	0.0	6.4	6.2	16	-	24	3	0.0
		1970	-	-	-	-	-	-	-	-	-	-	-	-
19	Yorston Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	55	-	0.0	0.0	0.0	-	7.0	15	-	15	6	.02
		1970	-	-	-	-	-	-	-	-	-	-	-	-
20	Bull Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	-	0.0	0.0	0.0	-	6.0	15	-	15	4	.05
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
21	Mountain Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	13	0.0	.03	.92	-	7.5	10	-	56	30	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
22	Trout Lake (North Bay)	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	6	0.0	0.0	.17	-	6.9	12	-	24	12	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-
23	Lake Nosbonsing	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	6	0.0	0.0	.21	-	7.2	10	-	20	16	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-
24	Tomiko Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	6	.2	0.0	.26	-	6.8	9	-	20	7	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
25	Red Cedar Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	14	.2	0.0	.09	-	7.6	11	-	44	31	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
26	Manan Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	10	.26	0.0	0.0	-	7.2	10	-	40	23	.12
		1970	-	-	-	-	-	-	-	-	-	-	-	-
27	Jumping Caribou Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	8	.26	0.0	0.0	-	7.2	12	-	28	13	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
28	Lake Temagami	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	11	.15	0.0	0.0	-	7.5	14	-	44	24	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
25	Red Cedar Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	14	.2	0.0	.09	-	7.6	11	-	44	31	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
26	Manan Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	10	.26	0.0	0.0	-	7.2	10	-	40	23	.12
		1970	-	-	-	-	-	-	-	-	-	-	-	-
27	Jumping Caribou Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	8	.26	0.0	0.0	-	7.2	12	-	28	13	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
28	Lake Temagami	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	11	.15	0.0	0.0	-	7.5	14	-	44	24	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
29	Rib Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	10	0.0	0.0	.09	-	7.2	10	-	32	16	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-
30	Lady Evelyn Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	10	0.0	0.0	.13	-	7.4	8	-	32	22	.16
		1970	-	-	-	-	-	-	-	-	-	-	-	-
31	Goward Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	10	.20	0.0	.13	-	7.4	18	-	34	13	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-
32	Martin Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	6	.15	0.0	.09	-	6.9	11	-	22	11	.14
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
33	Blue Lake	1963	--	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	6	0.21	0.0	0.0	4.8	5.5	26	-	20	2	0.02
34	Dana Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	5	0.0	0.0	0.0	5.4	6.8	17	-	20	6	0.0
35	Dougherty Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	5	0.0	0.0	0.0	4.0	4.8	21	-	20	2	0.01
36	Frederick Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	5	0.0	0.0	0.0	3.9	4.7	17	-	20	1	0.02
37	Gull Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	5	0.0	0.0	0.0	5.8	6.7	17	-	20	7	0.0

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
1	-	1963	-	.3	-	-	-	-	4.6	19	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
2	-	1963	-	.4	-	-	-	-	4.3	17	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
3	Wavy Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	6	.01	0.0	.20	4.1	4.6	21	-	20	3	-
		1970	-	6	.11	0.0	0.0	4.4	4.4	20	20	20	1	-
		1970	50	7.6	.05	0	0	3.6	5.1	18	-	22	4	.03
		1970	30	5	.09	0	0	4.7	6.3	20	-	16	1	0.0
4	Killarney Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	6	.01	0.0	.10	4.3	5.0	15	-	20	5	-
		1970	35	5	0.0	0.0	0.0	4.9	4.9	15	16	16	2	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	4	0	0	0	4.4	4.9	14	-	14	4	.04

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
5	O.S.A Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	5	.03	0.0	.10	4.1	4.8	15	-	20	4	-
		1970	50	5	0.0	0.0	0.0	4.8	5.0	17	16	16	3	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	4	0	0	0	4.1	4.9	15	-	14	3	.05
6	Three Narrows Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	5	0.0	0.0	0.1	5.2	6.7	16	-	20	5	-
		1970	25	5	0.0	0.0	0.0	5.5	6.0	14	15	18	4	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	5	0	0	0	5.2	5.8	13	-	18	5	.03
7	Nellie Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	3	0.0	0.0	0.1	4.4	5.1	17	-	14	4	-
		1970	40	5	0.0	0.0	0.0	4.6	4.7	14	14	20	2	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	3	0	0	0	4.0	5.8	14	-	12	2	.03
8	McGregor Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	140	8	.04	0.0	.10	7.4	6.5	15	-	86	71	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
9	Iroquois Bay	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	65	18	0.0	0.0	0.0	7.0	6.9	15	15	62	46	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	11	0	0	0	6.3	6.8	13	-	42	29	0.0
10	Norwest Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	9	0.0	0.0	0.0	6.8	6.9	13	14	32	14	-
		1970	50	6.7	0	0	0	6.5	6.6	12	-	24	13	.01
		1970	40	9	0	0	0	6.2	7.1	13	-	26	14	0.0
11	Panache Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	47	13	0.00	.005	.30	-	7.0	11	-	-	26	-
		1969	40	8	0.0	0.0	0.08	5.9	6.8	30	-	30	7	-
		1970	45	10	0.0	0.0	0.0	6.5	6.3	25	24	32	8	-
		1970	50	7.5	0	0	0	6.4	6.5	21	-	28	7	-
		1970	50	9	0	0	0	5.8	6.9	24	-	32	9	0.0
12	-	1963	-	7	-	-	-	-	6.8	23	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	7	0.0	0.0	0.0	6.2	6.6	20	20	26	8	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
13	Wakemi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	55	7	0.0	0.0	0.0	6.1	6.5	21	24	26	4	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
14	Whitefish Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	76	10	.05	.01	.09	-	6.4	22	-	9	-	-
		1969	50	9	0.0	.01	.10	6.4	6.8	31	-	34	9	-
		1970	60	9	0.0	0.0	0.0	6.3	6.5	29	28	32	8	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
15	Long Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	108	15	.15	0.0	.22	-	7.0	26	-	-	18	-
		1969	60	10	.05	0.0	.10	6.5	7.1	33	-	44	10	-
		1970	80	12	.22	.33	.08	6.5	6.4	31	31	44	13	-
		1970	70	14	.23	.00	.07	-	6.8	27	-	50	14	.02
		1970	40	12	.14	0	0	6.8	6.4	28	-	46	14	0.0
16	Lohi Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	8	.31	.08	.15	4.0	4.4	37	-	26	2	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	85	-	.09	.03	.06	3.6	4.8	21	-	20	2	.02
		1970												

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
17	Clearwater Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	70	7	.33	.06	.20	3.9	4.4	36	-	32	0.0	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	120	-	.30	.10	.09	3.5	4.3	26	-	20	0	.04
		1970	30	9	.39	.06	0	4.4	4.5	28	-	32	0	.03
18	Middle Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	100	11	1.36	.29	.19	3.9	4.4	58	-	50	2	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	180	13	1.47	.49	.10	-	4.6	47	-	128	1	.06
		1970	100	14	1.72	.45	0	4.7	5.2	48	-	60	0	.08
19	Kelly Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	823	76	4.9	1.45	4.5	-	5.7	494	-	-	4	-
		1969	1220	-	2.3	0.0	33.6	-	5.7	480	-	400	-	-
		1970	800	-	2.9	.12	.56	-	6.1	500	-	-	-	-
		1970	900	-	1.35	.08	.85	-	6.3	460	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
20	Bell Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	30	5	0.0	0.0	0.15	4.8	5.3	17	-	20	5	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	5	0	0	0	4.8	5.7	16		20	5	.04

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
21	Hannah Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	110	13	1.73	.53	.15	4.0	4.3	73	-	58	2	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	85	13	1.75	.76	0.0	-	4.9	59	-	64	1	.09
		1970	110	13	2.05	.67	0	4.6	4.5	58	-	56	0	.09
22	Tyson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	0.0	.07	-	-	-	22	-	22	3	-
		1970	30	5.7	0	0	0	5.7	5.8	16	-	18	5	.02
		1970	30	5	0	0	0	4.7	5.5	21		20	4	.03
23	Robinson Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	130	20	.46	.04	.40	6.4	6.4	55	-	78	19	-
		1970	80	5	.45	.03	1.44	6.3	7.1	12	-	40	7	-
		1970	150	17	.64	.06	.46	-	7.1	40	-	72	12	.17
		1970	140	18	.5	0	0	6.5	6.4	41	-	66	16	0.0
24	Agnew Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	40	7	0.0	0.0	.24	6.7	7.2	9	-	22	13	-
		1970	50	-	-	-	-	-	7.4	11	-	-	11	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
25	Fairbanks Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	50	8	0.0	0.0	.10	6.7	7.2	16	-	32	15	-
		1970	55	9	.02	0.0	.08	6.9	6.4	15	15	28	15	-
		1970	50	11	0	0	0	6.6	6.9	15	-	24	13	0
		1970	40	8	0	0	0	6.5	6.4	14	-	30	17	0.0
26	Clarabelle Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	280	42	.15	.2	1.75	-	7.3	-	-	-	22	-
		1969	100	23	.97	.02	.15	6.7	7.0	87	-	86	7	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
27	Lady McDonald	1963	-	12	-	-	-	-	4.1	75	-	-	-	-
		1965	290	41	3.7	.45	.07	-	6.1	155	-	-	5	-
		1969	250	41	0.7	0.0	.15	7.0	7.0	180	-	162	20	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
28	Meatbird Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	295	27	4.3	.30	.16	-	4.6	187	-	-	3	-
		1969	220	32	3.1	.21	.3	3.8	4.2	200	-	162	2	-
		1970	300	38	3.5	0.0	.08	4.1	4.9	173	173	180	1	-
		1970	220	29	2.9	.19	.30	-	4.6	135	-	128	1	.06
		1970	-	-	-	-	-	-	-	-	-	-	-	-

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
29	-	1963	-	24	-	-	-	-	4.2	164	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
30	St. Charles Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	65	10	1.22	.45	.13	-	5.2	43	-	42	1	.15
		1970	120	10	1.4	.36	0	4.9	5.0	45	-	50	0	.09
31	Peter Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	60	5	0.0	0.0	0.0	5.4	6.1	22	-	20	5	0.03
32	Reef Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	5	0.06	0.0	0.0	4.6	5.4	18	-	20	4	0.03

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	SULPHATE Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
33	Annie Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	5	0.0	0.0	0.0	4.7	5.7	21	-	20	5	0.05
34	Bassoon Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	40	8	0.0	0.0	0.0	6.2	7.1	13	-	26	14	0.0
35	Bevin Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	5	0.09	0.0	0.12	4.5	5.7	20	-	18	3	0.01
36	Carlisle Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	4	0.0	0.0	0.0	5.0	5.6	14	-	16	5	0.03

SAMPLE LOCATION	NAME	DATE	SOLIDS Total	CALCIUM as Ca	NICKEL as Ni	COPPER as Cu	IRON as Fe	pH Field	pH Lab.	SULPHATE as SO_4	Oxid.	HARD $CaCO_3$	ALK $CaCO_3$	ZINC
37	David Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	4	0.0	0.0	0.0	4.2	5.1	13	-	14	3	0.0
38	George Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	20	4	0.0	0.0	0.0	4.9	5.8	14	-	14	5	0.04
39	Great Mountain Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	50	9	0.0	0.0	0.0	5.8	6.9	24	-	32	9	0.0
40	Johnie Lake	1963	-	-	-	-	-	-	-	-	-	-	-	-
		1965	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-
		1970	30	4	0.0	0.0	0.04	4.5	5.2	14	-	16	4	0.04

APPENDIX B

Snowfall Sampling Data

MELTED SNOW SAMPLES   Note: All results in ppm (mg/l)

Sample Location	Date	Cu		Ni		Fe		Hg	Pb	As	Hard.	Alk	pH	SO_4	Solids		
		T	D	T	D	T	D								T	S	D
1	31/1/70	0	-	.10	-	.06	-	-	-	-	3	3	6.3	5	60	5	55
2	5/2/70	0	-	.02	-	.09	-	-	-	-	1	1	4.6	5	50	5	45
3	31/3/70	0	-	.0	-	.54	-	0	0	-	-	-	4.3	2	10	-	-
4	10/2/70	0.59	-	.76	-	1.64	-	-	-	-	3	1	4.4	5	100	25	75
5	31/3/70	0.09	-	.25	-	4.15	-	0	0	0	-	-	5.9	3	-	-	-
6	1/4/70	0.1	-	0	0	.6	.05	-	-	-	2	0	4.5	3	30	10	20
7	1/4/70	0.7	-	.3	0.1	6.2	.15	-	-	-	6	2	4.7	3	40	10	30
8	1/4/70	2.9	-	1.7	.35	15.4	.49	-	-	-	8	2	4.6	5	110	85	25
9	31/3/70	0.98	-	.67	-	5.60	-	0	0	.04	-	-	3.8	10	40	-	-
10	8/4/70	8.0	.08	16.8	.12	54	.8	-	-	-	-	-	6.3	2	-	-	-

MELTED SNOW SAMPLES Note: All results in ppm (mg/l)

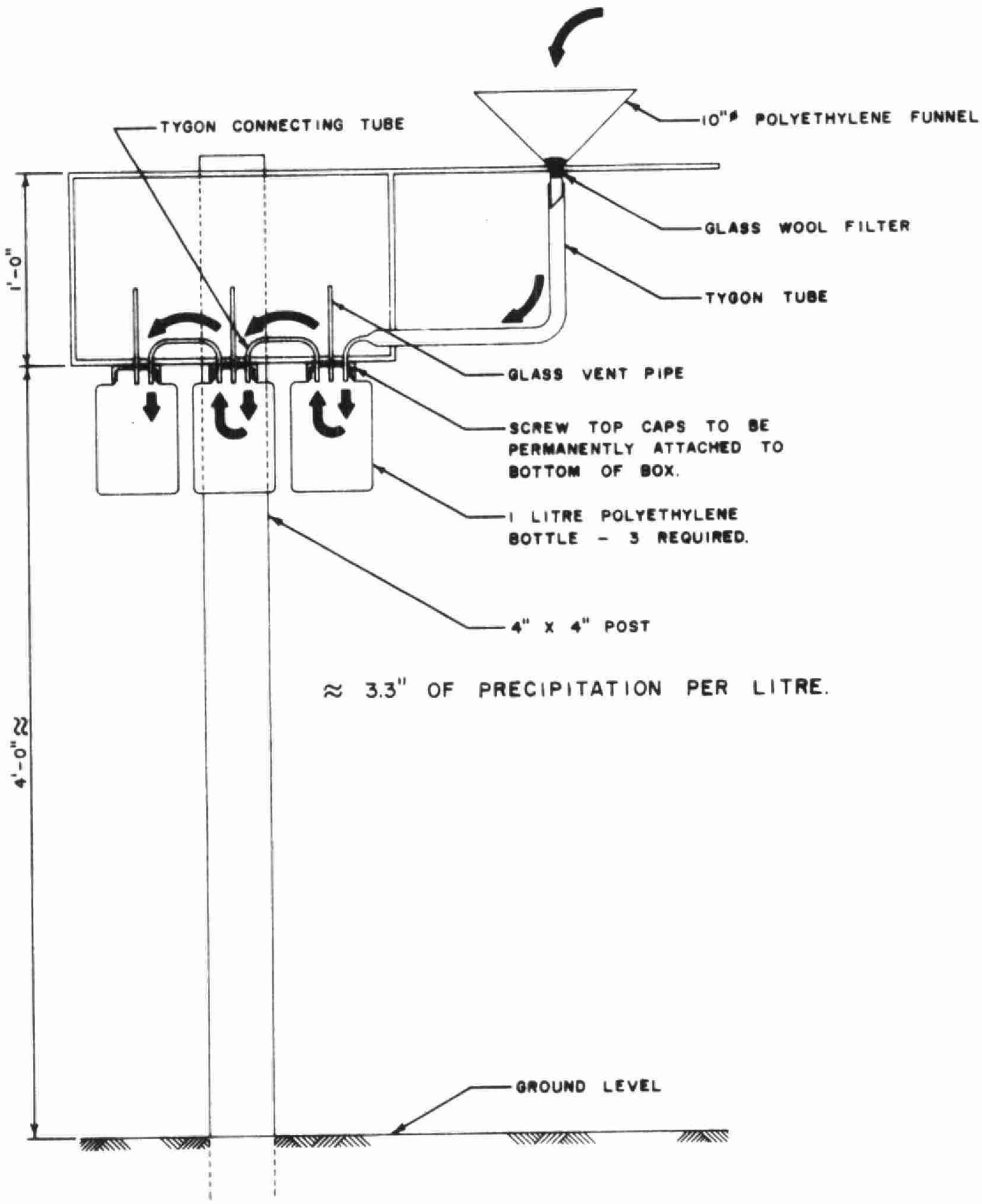
Sample Location	Date	Cu		Ni		Fe		Hg	Pb	As	Hard.	Alk.	pH	SO_4	Solids		
		T	D	T	D	T	D								T	S	D
11	1/4/70	2.2	-	1.5	.55	15.2	.38	-	-	-	20	4	5.0	3	450	400	50
12*	1/4/70	.18	-	0	0	1.3	.06	-	-	-	2	2	4.9	2	20	10	10
13	1/4/70	0	-	0	0	.3	.0	-	-	-	2	3	4.7	2	15	5	10
14	1/4/70	.2	-	0	0	1.9	.0	-	-	-	2	4	4.9	3	40	5	35
15	6/4/70	14	-	.24	-	2.6	-	-	-	-	2	4	5.1	1	20	-	-
16	6/4/70	.13	-	0	-	.76	-	-	-	-	2	4	5.1	2	30	-	-
17	1/4/70	.07	-	0	0	.6	-	-	-	-	22	3	5.3	22	60	-	-
18	26/3/70	1.04	0	.32	.02	11.2	.46	-	-	-	-	-	4.7	4	-	-	-
19		4.4	.03	4.0	.06	84	.92	-	-	-	-	-	5.7	5	-	-	-
20	4/3/70	.0	.04	-	.06	-	-	-	-	-	-	-	4.4	3	-	-	-
21	4/3/70	.0	.04	-	.06	-	-	-	-	-	-	-	4.4	3	-	-	-

* ALSO SAMPLED FOR SE - 0.0 ppm
TE - 0.0 ppm

APPENDIX C

Rainfall Sample Data

RAIN COLLECTING STATION
(FRONT VIEW)



70-178-9L

RAINFALL DATA -June, 1970.

Station No.	Name	Conduct.	pH	Cd	Cr	Cu	Ni	Zn	Co	Fe	Pb	Mn	Mo	V	SO_4
1.	Penage	28		4.5	.5	80	15	175	0	9	6	16	.5	0	0.6
2.	Skead	42	4.10	3	.5	80	60	340	2	90	20	8	.1	0	8.2
3.	Killarney	42		3	.4	55	7	120	0	30	20	27	.3	0	NS
4.	Meldrum Bay	29		2	.1	40	1.5	275	0	7	12	14	.3	0	-0.3
6.	Windy Lake	24	4.66	2	.1	12	3	120	0	7	10	11	.1	0	-0.3
7.	Stinson	24	5.40	2	.1	140	5	45	0	10	6	12	.1	0	1.9
8.	Township 0	24	4.41	0	0	72	2	72	0	11	30	4	.3	0	1.1
9.	Gogama	18	5.57	14	.1	15	1	55	0	22	18	20	.5	0	1.1
10.	Temagami	26	3.92	2	.1	55	1	75	0	15	17	15	.2	0	3.0
11.	Espanola	31	4.57	2	.1	25	1	125	0	25	19	15	.1	0	0.7
12.	McFarlane L.	40	4.65	2	.1	25	5	300	0	4	15	14	.3	0	14.1

All results in ppb (parts/billion)

RAINFALL DATA - July, 1970

Station No. Name	Conduct.	pH	Cd	Cr	Cu	Ni	Zn	Co	Fe	Pb	Mn	Mo	V	SO_4
1. Penage	28	4.30	0	.3	16	5	36	0	15	10	8	.1	0	0.4
2. Skead	41	3.92	0	.2	64	76	240	2	123	28	6	.3	0	15.2
3. Killarney	25	4.20	2	.3	20	10	52	0	52	24	8	.3	0	-0.3
4. Meldrum Bay	20	4.52	4	0	24	6	80	0	61	45	14	.2	0	-0.3
6. Windy Lake	22	4.30	0	.3	18	7	132	0	35	17	12	.1	0	-0.3
7. Stinson	27	4.59	2	0	120	10	52	0	34	9	12	.1	0	-0.3
8. Township 0	22	4.47	1	0	32	5	192	0	23	12	10	.3	0	0.6
9. Gogama	20	4.72												NS*
10. Temagami	23	4.04	12	1	80	6	88	0	34	32	8	1	0	0.9
11. Espanola	41	6.31	7	.6	48	7	252	0	74	38	16	0	0	-0.3
12. McFarlane L.	45	3.80	3	.6	112	80	360	0	104	34	4	.2	0	10.8

* NS = no sample

RAINFALL DATA - August, 1970

Station No.	Name	Conduct.	pH	Cd	Cr	Cu	Ni	Zn	Co	Fe	Pb	Mn	Mo	V	SO_4
1.	Penage	22	4.57	2	.2	24	4	30	0	70	9	7	note	0	
2.	Skead	34	4.11	3	.8	220	120	280	6	550	19	22	2.9	0	
3.	Killarney	40	4.22	1	.2	28	6	28	0	96	22	10	.3	0	
4.	Meldrum Bay	18	7.21												
5.	Jamot	59	4.35	6	1	72	80	52	0	66	48	22	.4	0	
6.	Windy Lake	59	4.20	3	.1	32	7	36	0	65	19	7.5	2.2	0	
7.	Stinson	110	3.71	5	.2	128	36	28	.5	230	44	9	.7	0	
8.	Township 0	26	6.08	2.5	.1	40	13	36	0	110	12	12	1.1	0	
9.	Gogama	21	5.08	1	0	8	2	24	0	40	15	6	.1	0	
10.	Temagami	56	4.11	2	.6	36	7	36	0	136	24	13	.3	0	
11.	Espanola	69	4.90	3	.4	20	9	120	.4	70	24	27	.5	0	
12.	McFarlane L.	68	4.20	11	3	240	236	380	5	900	39	15	2.5	0	

Note: Station 1, Penage, recorded a Mo value of 8,000 ppb which has been traced to contamination of sample.

RAINFALL DATA - September, 1970

Station No. Name	Conduct.	pH	Cd	Cr	Cu	Ni	Zn	Co	Fe	Pb	Mn	Mo	V	SO_4
1. Penage	3	4.45	2	0	10	2	50	0	24	8	10	1	0	
2. Skead	29	4.30	2	8	26	30	184	.7	72	22	7	0	0	
3. Killarney	16	4.80	2	.2	16	2	110	0	28	8	9	4	0	
4. Meldrum Bay	101	7.15	2	0	42	7	78	0	22	18	3.5	1	.5	
5. Jamot	58	6.68	.4	0	14	7	64	0	20	8	6.5	.6	0	
6. Windy Lake	28	4.27	.4	1	16	2	60	0	20	14	3.5	0	.2	
9. Gogama	11	4.61												
10. Temagami	20	4.43	2	1	17	3	76	.2	32	14	6	.6	0	
11. Espanola	37	4.72	1	.3	4	2	40	0	26	14	6	0	1	
12. McFarlane L.	22	4.45	2	0	80	35	150	.6	44	11	5	0	.2	

RAINFALL DATA - October, 1970

Station No.	Name	Conduct.	pH	Cd	Cr	Cu	Ni	Zn	Co	Fe	Pb	Mn	Mo	V	SO_4
1.	Penage	19	5.42	7	.9	16	12	68	.4	24	8	13	1.0	1.0	
2.	Skead	37	4.10	32	1.3	100	72	152	2	140	25	23	.8	.4	
3.	Killarney	27	6.60	6	.4	16	6	20	.4	28	14	12	4.0	2.0	
5.	Jamot	24	4.00	8	.4	12	8	40	.4	30	18	36	.2	.5	
6.	Windy Lake	51	3.72	44	1.4	100	26	96	.6	88	41	11	.2	2.0	
9.	Gogama Lake	30	3.89												
10.	Temagami	24	4.10	6	.8	48	6	68	0	34	12	12	0	.5	
11.	Espanola	2100*	8.60	4	0	48	8	52	0	0	10	0	3.3	0	
12.	McFarlane L.	35	3.93	12	.6	120	66	40	1.2	66	22	15	.2	1.0	

* Conductivity suggests sample has been contaminated (#11. Espanola).